Notification: Data driven study on seismic structural features of Groningen ground motions
Organisation: Ministry of Economic Affairs and Climate Policy

Purpose of the notification
The purpose of this notification is to determine whether there are parties interested to perform the above mentioned assessment.

State of the art, background
Many questions or comments, coming from the MEA and SodM and Groningen NCG knowledge platform meetings and NPR, refer to "horizontal and vertical seismic signatures". The main concerns raised are a) the overall validity of the risk assessment model b) explanations for the effects of the strong subsurface heterogeneity in the Groningen area, and c) the determination of 3D seismic input for deriving the fragility functions used in the seismic risk assessment from NAM.

Earthquakes observed so far in the Groningen area are of low magnitude, which is often neglected in hazard and risk studies in active crustal regions. The upgrade of the seismic network provides an excellent opportunity to investigate a) whether the seismic demand on structures imposed by the Groningen events has features relevant for seismic risk assessment and b) whether the ground motion prediction equations and the fragility functions derived are fit for purpose, when it comes to ground motion modelling.

Objective
The objective of the project is to better understand characteristics of induced earthquakes and propagation seismic waves of Groningen and their effects on seismic structural response and to identify possible modelling improvement strategies. The study should employ empirical analysis based especially on the 3D seismological data from the new surface networks. And possibly numerical simulations of wave propagation through complex media to identify distinctive features, if any, of Groningen ground motion with respect to seismic structural response. With special attention to the seismic response measures that are used for the risk assessment by NAM. The output of the project will be used to validate or improve the existing Ground Motion Prediction Model of NAM and for deriving relevant time-series for earthquake engineering related questions, that is Groningen seismic risk assessment.

Research questions

Research Question 1: Analysis of the 3D features of the Groningen earthquakes wave fields with respect to engineering demand parameters relevant to seismic risk assessment in the area. Evaluate quantitatively the Groningen risk assessment model in terms of 3D features of ground motions considered and their impact on the seismic structural response at multiple sites. The analysis should include structural models relevant for the area even at the single degree of freedom (SDoF level) and benchmark analysis.

Research question 2: Wave propagation through heterogeneous media. Develop a 3D heterogeneous wave propagation model for the Groningen area based on the rich existing geological, geophysical, geotechnical and seismological data and including the shallow subsurface. The model should use open-source software frameworks. The model should be able to reproduce the observed key features of the observed seismicity up to frequencies of 5 Hz. It should be used to address some of the key issues addressed before, and allow for scenario and sensitivity studies. Some of the specific questions can include, for example:

- What is the effect of Zechstein Salt Formations of variable depth and shape on the seismic wave propagation and observed ground motions?
- Can the model reproduce the observed relationship between signal frequency and duration of S waves, which influence the seismic demand?

- Discuss the relative importance of topography and near surface geology heterogeneity for variations in wave propagation and ground motions for seismic demand analysis at multiple sites.

Research question 3: Improving ground motion predictions
- Based on result of questions 1 and 2, review the existing NAM models and comment on possible future improvements and data requirements.
- Discuss potential implications for seismic structural assessment.
- Discuss if simulation-based frameworks based on 3D wave propagation in heterogeneous media are a viable alternative to the existing GMPE framework.

Deliverables expected

1. Report on research question 1 (Months 6);
2. Report on Research question 2 (Months 9-12);
3. Note with Recommendations for development of the public version of the Groningen risk assessment model.

Note that these reports will be open access. Publication of results in peer reviewed journals is not required but encouraged.

Timeline

12 Months when deliverable 2 can be delivered in parallel to 1 within six months.
If consortia contribute to the achieving proposal timeline, this is encouraged.

Required skills / experience

3D Seismic full wave propagation software and expertise (Universities or main seismic contractors)

Seismological data analysis software and expertise (seismological institutes and geotechnical institutes).

Knowledge of Groningen risk assessment model.

Application

Interested companies / consultants, fitting the above mentioned requirements, are invited to respond to Procurement Office of the Ministry of Economic Affairs and Climate Policy, to the attention of Ms. Astrid van Mastrigt by e-mail IUCEZteam5@rvo.nl.

You do not have to send documents, only an e-mail if you are interested.

Interested parties will receive the request for the tender by e-mail, as soon as possible after the deadline for responding to this Notification.

The deadline for responding to this Notification is set at **13 June 2018, 12.00 CET**.